approved himself sufficiently in the college examinations. Scholars are practically required to become candidates for honours in the natural sciences tripos, though the new mechanical sciences tripos will no doubt attract some. The new Salamon scholarships at Caius are, indeed, specially intended for students of engineering. It should be added that candidates for scholarships, who are not yet members of the university, must be under nineteen years of age ; there is no restriction of age in respect of the science exhibitions. Though only nine colleges specifically offer entrance scholarships in science, an examination of the awards to the first, second, and third year students shows that in many more good work in science, as tested by university or inter-collegiate examinations, does not go unrecognised. The large body of medical students, now approaching five hundred in number, is distributed over all the colleges, and their presence has apparently brought home, even to the most conservative, the fact that intellectual ability, high-minded devotion to study, and social energy are not confined to students of classics and mathematics alone. Thus, though something remains to be done in certain quarters in the direction of placing science on an equal footing with the older subjects as a fit object of college recognition and reward, it must be owned that a great advance has been made within the last ten years. The natural sciences tripos now attracts a larger number of candidates than any other, and this notwithstanding that its standard has steadily been raised. In the majority of the colleges, distinguished eminence in this tripos has been admitted as a qualification for a fellowship, and in not a few instances governing bodies have felt the need of strengthening themselves on the side of science, and have departed from Cambridge custom by selecting scientific members of other colleges for this honour.

The endowments for research, other than scholarships and fellowships, have in late years been substantially increased. In addition to post-graduate studentships at the larger colleges, such as the Hutchinson at St. John's (physical and natural science), the Coutts-Trotter at Trinity (physics and physiology), the Frank Smart at Caius (botany), the university has of late received a number of benefactions for the same purpose. The Balfour studentship in animal morphology, worth £200 a year, the Harkness scholarship in geology about £100, the Clerk Maxwell scholarship in physics about £185, the John Lucas Walker studentship in pathology £200 to £300, the Isaac Newton studentships (three) in astronomy £200, and the Arnold Gerstenberg studentship, for natural science students pursuing philosophical study, about £55, are among these recent foundations. They are expressly intended to foster advanced study and research, and they have already produced excellent results. The university still lacks the means of providing similar encouragements for higher work in chemistry, in anatomy and anthropology, in botany, in mineralogy, in physiology, in pharmacology, and in scientific engineering. It is to be hoped that the line of generous benefactors is not yet extinct, and that some of these important subjects may ere long receive the benefit of their munificence. The new scheme for the promotion of post-graduate study and research, which has received the approval of the senate, and now only awaits the assembling of Parliament for the sanction of the necessary statutes, will render such endowments opportune and fruitful.

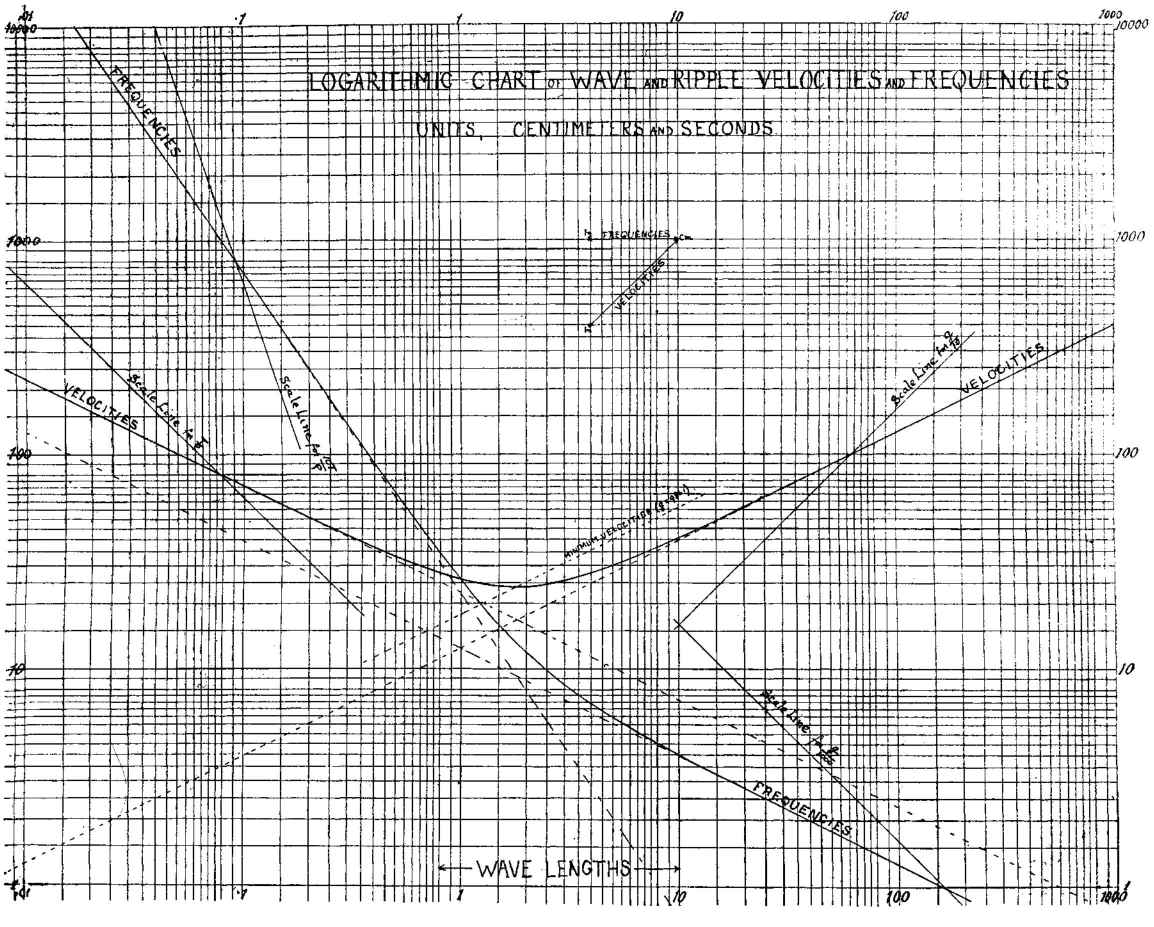
SCALE LINES ON THE LOGARITHMIC CHART

THE advantages of logarithmic plotting for certain classes of work have for some time been recognised, and now that, thanks to Mr. Human, logarithmically ruled paper can be obtained ready made, the facility of such plotting is greatly increased, so that there is all the more reason on this account why it should become more common than it seems to be at present. It may perhaps be well to point out shortly what the nature and effect of logarithmic plotting is, and to contrast it with the more common method on square-ruled paper. Instead of paper ruled in equal squares, logarithmic paper is ruled first in a series of large equal unit squares representing tenfold changes in the coordinates. Thus two units represent 100, three units 1000, and so on. Similarly the squares are broken up fractionally and unequally into a series of vertical and horizontal lines, whose distance from the left or lower side of the square is equal to the logarithms of the numbers 2, 3, 4, &c., and these are subdivided again logarithmically just in the same way that a slide rule is subdivided. In fact, if logarithmic paper is not available, logarithmic plotting can still be carried out fairly expeditiously by pricking off distances direct from a good slide-rule. The meaning of lines drawn upon logarithmic paper is very different from that upon ordinary square ruled paper. For instance, an inclined straight line ruled in the ordinary way represents the equation $y = a + bx$, whereas when logarithmic paper is employed the corresponding line gives $y = ax^b$. The consequence is that whenever two quantities are related so that one varies as any power, positive, negative, integral, or fractional of another, a straight line drawn in the proper position and inclination represents that relation, the power being equal to the trigonometrical tangent of the angle of slope of the straight line. If the relation that is to be represented is less simple, if the index changes gradually as either of the coordinates changes, so that a curve has to be employed, then the size and shape of the curve represents the law in the abstract, and the position of the curve on the sheet the actual numbers for the particular case and with the particular units ; a mere shift of the curve bodily upon the chart, as pointed out by Prof. Osborne Reynolds long ago, being all that is necessary to adopt the same law to new circumstances or new units.

One very important feature of logarithmic plotting is the fact that, not only is it practicable to include an enormous range (in Mr. Human's sheets of four by five squares of 10,000 and 100,000 in the two directions), but the proportionate accuracy is identical in all parts, if it is possible to draw or read to, say, 1 per cent. in one part of a curve, the same figure is true everywhere. On the other hand, in ordinary plotting the proportionate accuracy of quantities near the origin is very small, while at a great distance it becomes enormous. In order to assist in the process of sliding any curve about on a logarithmic chart so as to represent particular cases, special logarithmic scales may be ruled upon the sheet, having a suitable magnitude depending on the index which connects the result with the new variable, or what I have called scale lines may be employed. In illustrating the laws which connect the velocity and frequency of waves and ripples at the Royal Society soirée, I exhibited these lines, and showed how, in order to determine by inspection either the velocity or the frequency of waves and ripples of any wavelength on the surface of any liquid under any acceleration of gravity, a single curve and two scale lines are all that are needed. As by their use the logarithmic chart is made even more comprehensive than it is at present, I feel that no apology is needed for making use of the columns of NATURE to make them more widely known.

As is well known, the velocity of surface waves on a fluid depend both on gravity and on kinematic capillarity or capillarity divided by density. In the case of waves of large size, capillarity is of practically no account, and the velocity depends only on the acceleration of gravity. Since it depends on the square root of this acceleration, the line on the logarithmic chart that represents the velocity of waves of any size travelling under the influence of gravity alone is straight, and slopes up so as to rise one square for every two that it moves to the right, its tangent is

$= \frac{1}{2}$. On the other hand, since the velocity of waves travelling under the influence of capillarity alone is proportional to the square root of the wave shortness or reciprocal of the wave-length, the line that represents their velocity is straight also, but slopes the other way and to the same extent. Actually both causes are in operation, but except over a range of wave-length of about 1 to 100, the one influence so largely predominates that the other is negligible. In the diagram this is made evident on the velocity curve which consists of two straight branches joined by a curve, which runs into them and is rapidly indistinguishable from them. The dotted continuation of the branches shows what would be the velocities under the influence of either cause alone. Where the two lines cross, both gravity and capillarity have equal influence, and the two together produce a minimum effect. The actual curve may be planted anywhere on the chart; but in the diagram it is so placed as to represent the facts with water for which $T/\rho = 81$ and with $g = 981{\cdot}1$. If other liquids are chosen, then, since the gravitational branch of the curve is unaffected, the curve, as a whole, must be made to slide along the gravity branch on the right until the left branch assumes its proper position. Similarly to represent the effect of changes of g, the curve must be made to slide along its capillary branch on the left until the gravity branch on the right assumes its proper position. The proper position in either case may be indicated by a special logarithmic scale ruled to half the scale adopted for the squares of the chart, and placed upon the chart with its length vertical and so that the branches of the curve cut each scale, one at 81 and the other at 981·1. The *scale line*, however, is much simpler, more convenient, and less confusing. In order to draw it, find a point in either branch of the curve where the velocity reading on the vertical scale of the chart is equal to the value of T/ρ for the left, or of g for the right branch. If within the limits of the paper the branch of the curve does not indicate a velocity, of which the value is T/ρ or g, as the case may be, take some whole power of 10 or $\frac{1}{10}$ as a factor. For instance, though $T/\rho = 81$ is within the limits of the left branch, $g = 981{\cdot}1$ is outside the paper on the right, therefore find on the right branch $g/10 = 98{\cdot}11$. Now, in order to find some other point on the scale line, imagine that each of these quantities is multiplied tenfold. The corresponding branch of each will be raised vertically $\sqrt{10}$, or half a square. The new line so drawn will at some point cut the vertical scale of the chart, in a line of which the value is ten times the reality, or is one square higher up than the first point. Mark this point, and join it to the first. The result is a *scale line* having the property that wherever it is cut by the corresponding branch of the curve the reading on the chart gives at once the value of T/ρ or of g, as the case may be, that is proper to the new position of the curve, and conversely in order to fix the place of the curve for any value of T/ρ or of g, it is merely necessary to find the desired values of these quantities on the scale lines, and then to shift the curve until its two branches or its two branches produced if necessary pass through the points on the scale lines having the values sought. If the effect of a variation of the constant upon the value indicated by the curve line is one of simple proportion, the scale line will be vertical. If its power is less than one, it will be



between the vertical and the slope of the curve; if more than one, it will slope the other way, if it is negative the slope will be less than that of the curve. In order to apply a general rule to all possible cases where both the index connecting x and y and the index connecting the result (y) with the variation of the constant may have any values whatever, it is merely necessary to find a point a upon the inclined straight line representing $y = ax$, at which y is equal to a, or to that part of a which may assume various values. At any distance above it rule a horizontal line. Where the horizontal line cuts the inclined line, write the figure 0; where it cuts the vertical through the point a, write the figure $+1$. Then complete a scale of equal parts on the horizontal line extending to $+\infty$ and $-\infty$. Lines drawn through the original point a and any point q on this scale will be scale lines corresponding to the case where the result depends upon the qth power of the constant as well as upon the bth power of x.

The frequency curve placed upon the same chart has two branches inclined at $\tan^{-1} - \frac{3}{2}$ and $\tan^{-1} - \frac{1}{2}$, joined by a curve such that not only on the straight branches, but at every point, the algebraical difference of the tangent of its inclination and that of the velocity curve for the same value of x the wave-length is equal to unity. The left-hand branch of the frequency curve supplies another example of the rule given above for drawing a scale line; for, while its tangent is $-\frac{3}{2}$, that of the scale line is -3.

It is evident that the curve may be conveniently drawn upon tracing-paper, which may then be moved about, but always keeping the inclinations unchanged until the branches pass through the desired points upon the scale lines. The numerical relations for the new constants may then be read at once.

I have thought it best to explain the method by the use of a concrete example. Of course it is not limited to the case of ripples and waves, but may be applied very widely.

By way of illustrating how to change from one system of units to another, I have drawn a pair of double-ended arrows in the middle of the chart, which show the magnitude and direction of the movement of each of the curved lines with its straight dotted continuations, which will be necessary in order to read the results in inches instead of in centimetres. The one relating to velocities is inclined at 45°, as both the velocity and wave-length are equally changed in the ratio of 2·54 : 1, or 1 : ·3937. On the other hand, the frequency being a mere number is not affected, except in so far as the wave-length will be expressed by a different number. Hence the direction of sliding is here horizontal and the same in amount as either component of the other. The scale lines must then be put in parallel to their former directions, and running through points for which the vertical scale reading has the numerical value of the constant according to the system of units chosen.

C. V. BOYS.

[*Note.*—The numerical values represented by the vertical and horizontal lines in each square in the diagram are 1, 1·5, 2, 2·5, 3, 3·5, 4, 4·5, 5, 5·5, 6, 6·5, 7, 7·5, 8, 9, 10. The number of lines in the Human sheets is five times as great, but they are drawn in three degrees of darkness to distinguish them.—C. V. B.]

NOTES.

A REPRESENTATIVE meeting of friends and admirers of the late Mr. Huxley was held on Thursday afternoon, at the rooms of the Royal Society, under the chairmanship of Lord Kelvin, P.R.S., to consider what steps should be taken to initiate a national memorial. It was determined to call a general public meeting after the autumn recess, and, in the meantime, to form a general committee. Sir John Lubbock (15 Lombard-street) has consented to act as treasurer, and Prof. G. B. Howes (Royal College of Science, South Kensington) as secretary to the provisional committee.

WE notice, also, that it is proposed to establish a memorial to commemorate the connection of Huxley with the Charing Cross Hospital Medical School. At a meeting held at the School on Tuesday, the following resolution was passed:—"That the memorial shall take the form of a Huxley scholarship and medal to be awarded annually at the Charing Cross Hospital Medical School, and that if funds permit an annual public lecture at the Charing Cross Medical School dealing with recent advances in science, and their bearing upon medicine shall be instituted."

WE understand that a large majority of those Fellows of the Royal Society who have expressed an opinion on the matter, being in favour of retaining the present quarto form of the *Philosophical Transactions*, the President and Council have decided to retain that form. As stated in a circular recently addressed to Fellows, the President and Council, finding that the majority of those expressing their opinion were in favour of a royal octavo form for the *Proceedings*, have decided to adopt that form. The change will probably be made at the beginning of next year.

SEVERAL new instances of generous gifts for the advancement of scientific knowledge are reported in *Science*. Mr. Archibald, President of the Trustees of Syracuse University, has offered to be one of six subscribers for funds to build a hall of science costing about £30,000. The University has also been offered £2000 and £20,000 towards a new medical college. Another American institution which has benefited by the epidemic of generosity which has lately prevailed in the United States is the Johns Hopkins University, which has received from Mrs. Williams a sum of money sufficient to establish a lectureship in geology in memory of the late Prof. George H. Williams. Sir Archibald Geikie has been invited to be first lecturer.

THE sum of £50,000 required for the New York Botanic Garden has been contributed by twenty-two donors. Subscriptions of £5000 were given by each of the following:—Mr. J. P. Morgan, Columbia College, Mr. Andrew Carnegie, Mr. C. Vanderbilt, Mr. J. D. Rockefeller, Mr. D. O. Mills, Judge A. Brown. Mr. Wm. E. Dodge, Mr. J. A. Scrymser, and Mr. Wm. C. Schermerhorn each gave £2000, and there were eight subscribers of £1000 each. The act of incorporation required that this amount be collected for an endowment. The city must now raise £100,000 by bonds for building purposes, and provide 250 acres of land in Bronx Park. This part of the agreement will probably soon be carried out, so New York may look to possessing shortly a botanic garden of the first order. Writing with reference to the prospect in *Science* of July 5, Prof. G. L. Goodall, of Harvard University, remarks: "To Columbia College and the other educational institutions of New York and vicinity, this new appliance for instruction will mean indeed a great deal. To all the citizens who are to take advantage of the opportunities for instruction which the garden will afford, Bronx Park will be a constant delight. But far beyond these limits, wide as they are, the garden will exert a profound and beneficial influence. Other cities will surely be stimulated by this noble movement and enrich their park systems with an educational aid of the greatest value. Formerly botanic gardens, attached even in a remote manner to educational institutions, were largely used for the cultivation of medicinal plants, and for the reception of species from distant lands. Of course, this use, although its importance is now relatively less than ever before, will still long continue to be a factor in the direction of activities. But here and there new phases of plant